Appendix A

Appendix A Site specific Analysis

Winkleman Dome (See Fig. 3 also)

Site W-1 and the stream segment from the NPDES Discharge point to the pond at W-1.5 (black) *

Site	Site name	Str or Lk name	II_Geology	VI_Ros I_1	VI_Ros II_1	VI_Ros I_2	VI_Ros II_2	elev	Lat	Long	VIII_Anth_Ps_6	IX_Degree_6	Lim Season_6	X_Status	XI_Mgmt
W-1	Winkleman Dome-1 (above dead duck pond)	Winkleman Dome Creek	Sed	G ? C ?	4			6000	43° 06' 14.9"N	108° 50' 03.1"W	NPDES_O&G	Dep	AS	NS	Perm

*The tables at the beginning of each site are a query from the WREQC database. Column One (C1) is the Site acronym, C2 is the site name, C3 is the stream name or in many cases the WREQC proposed name for the stream segment, C4 is the geology that the segment is found in, C5 and C6 is the tentative Level II Rosgen classification for the segment and in some cases, if a second Rosgen Class is needed, C7 and C8, C9 is the site elevation in feet, C10 and C11 are the Latitude and Longitude respectively, C12 indicates that this is produced water from NPDES discharges,C13 indicates the tentative degree that the produced water influences the segment with Dep meaning dependent and it is all produced water, dom meaning that the segment is dominated by the produced water but other water is mixed in, and inf means it is influenced by the produced water but mostly has characteristics of a basin stream, C14 indicates if the effects are seasonal with AS meaning all seasons and not seasonal, C15 is our preliminary evaluation of the beneficial uses with NS meaning not supporting, PS meaning partially supporting, and FS meaning fully supporting, and lastly C16 is the action being recommended with Perm meaning we are going through the EPA and the permitting process to address any issues with this stream segment.

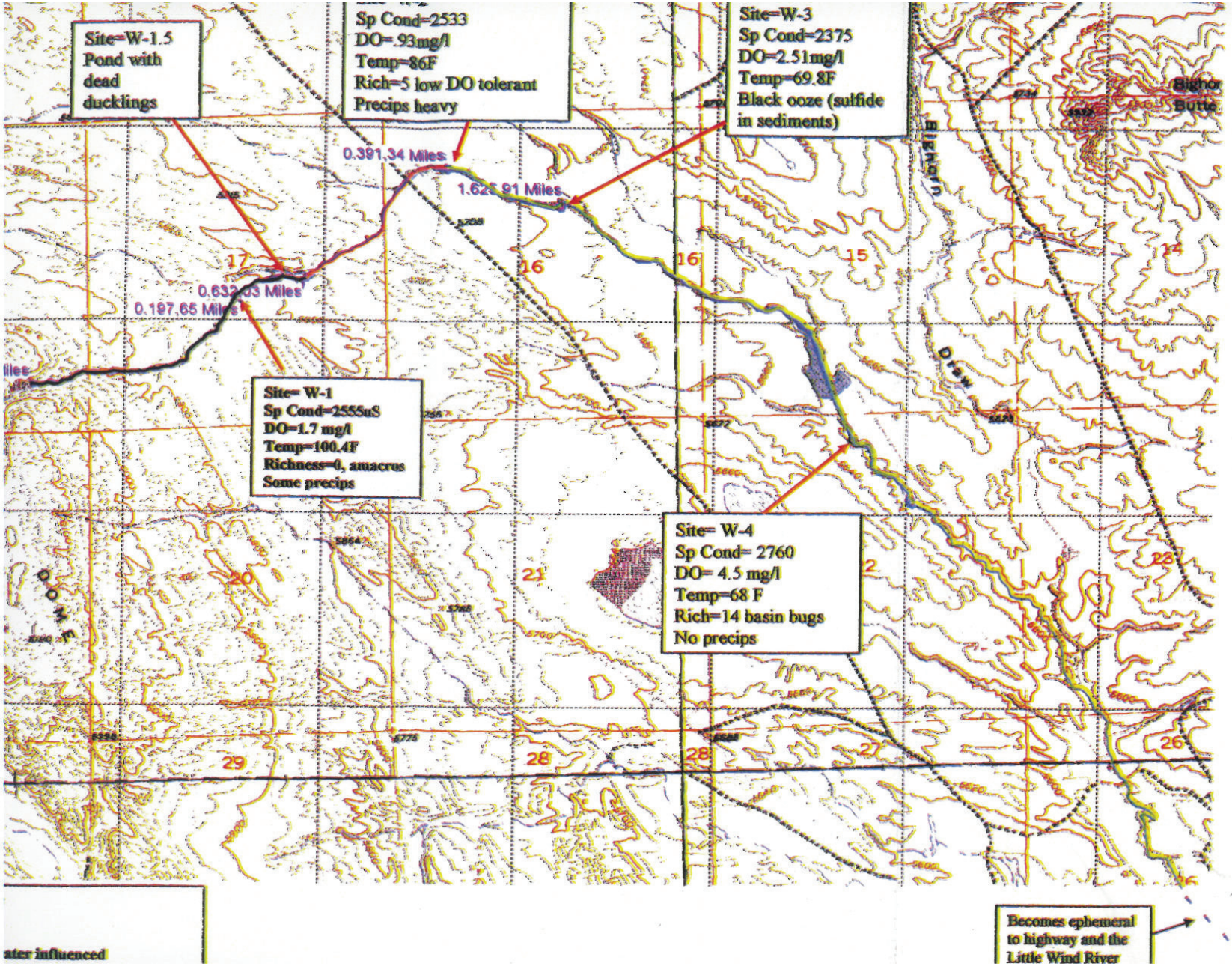
This segment is tentatively classified as a Rosgen G4, oil and gas (O&G) dependent (Dep) for all seasons (AS) and non-supporting of its beneficial use (NS). Management of this segment is through the permitting process (Perm).

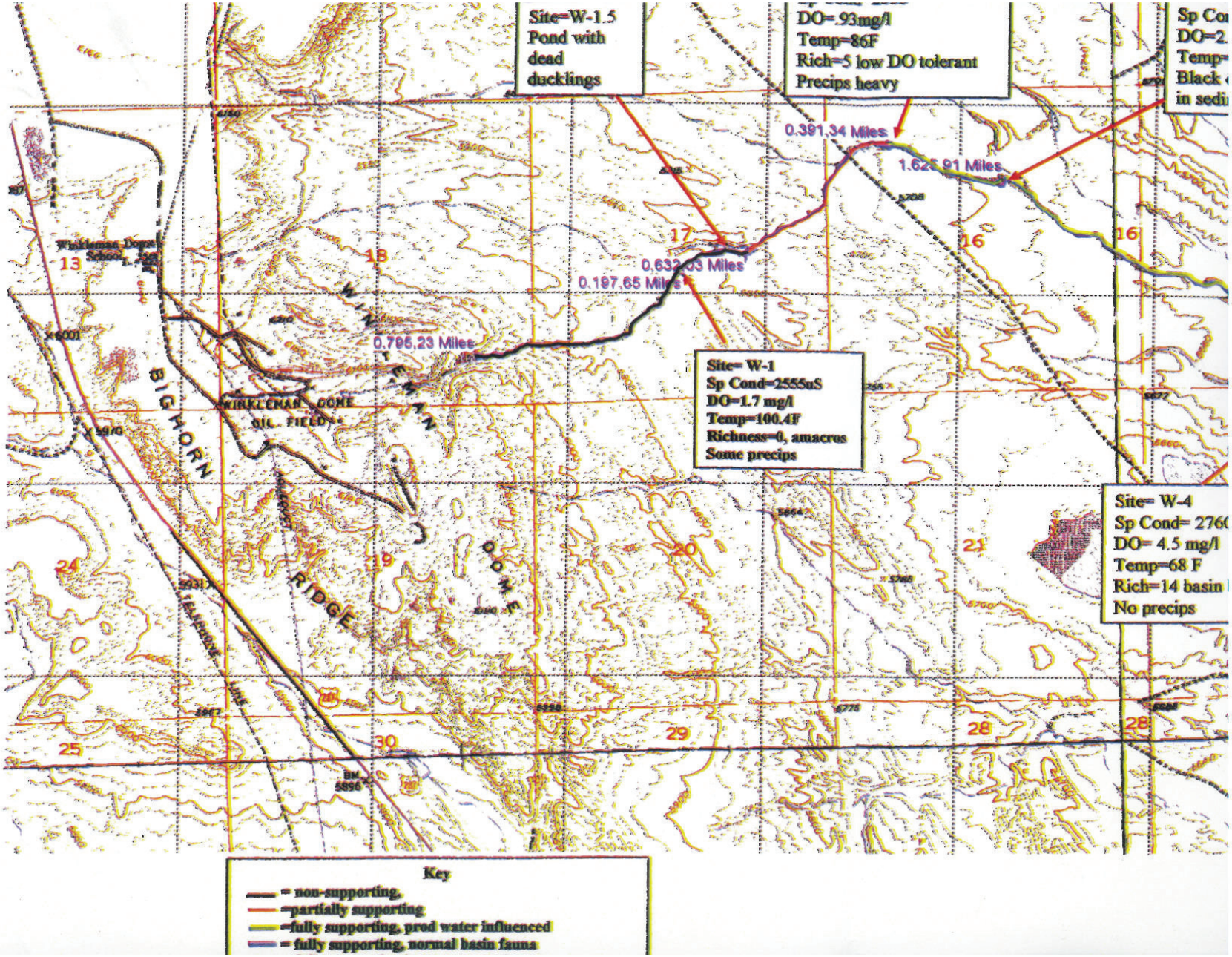
The sediments at the first sampling location had an elevated concentration of petroleum hydrocarbons (6740 mg/kg). Although this is not alarmingly high, it does exceed the Bureau of Indian Affairs (BIA's), guideline for cleanup of petroleum contaminated soils on Tribal oil and gas leases (1000 mg/kg). Concentrations of metals and radionuclides in the sediments increase downstream of the discharge point, apparently due to precipitation of dissolved solids (See Table II).

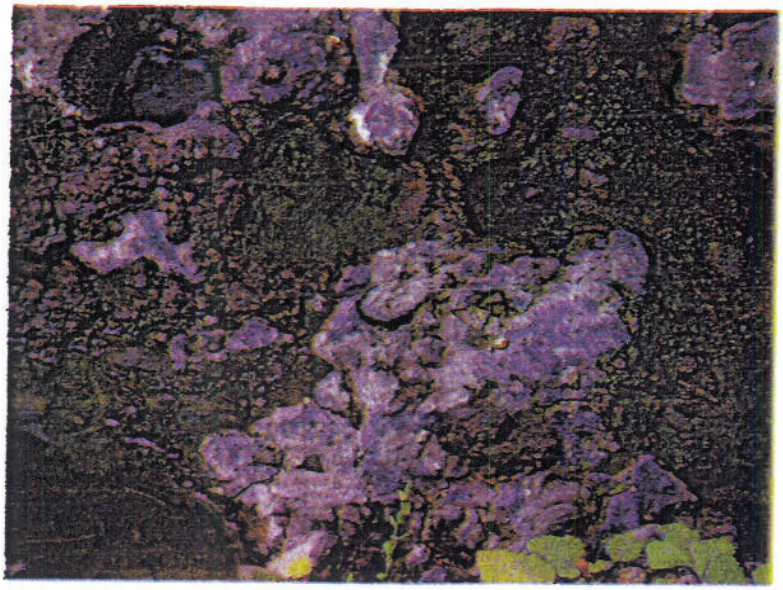
There were no macroinvertebrates at this site and in the upstream segment. The high temperature of the water, 100 degrees F, caused a low DO reading of 1.7 mg/l and kept the high sulfides, 25,200 ug/l, in solution through most of this segment. The segment is colored black in Fig. 3 to indicate that this is a zone devoid of macroinvertebrates and not meeting its beneficial use for aquatic life and we recommend that there be treatment of this water before it is released.

W1-1: The deer flies necessitated the head nets. This stream segment is entrenched in a gulley and has a steeper slope than downstream segments.

Insert Fig. 3


Site=W-1.5
Pond with
dead
ducklings
Sp Cond=2533
DO=.93mg/l
Temp=86F
Rich=5 low DO tolerant
Precips heavy
Site=W-3
Sp Cond=2375
DO=2.51mg/l
Temp=69.8F
Black ooze (sulfide
in sediments)
0.391.34 Miles
1.625.91 Miles
0.632.03 Miles
0.197.65 Miles
Site= W-1
Sp Cond=2555uS
DO=1.7 mg/l
Temp=100.4F
Richness=0, amacros
Some precips
Site= W-4
Sp Cond= 2760
DO= 4.5 mg/l
Temp=68 F
Rich=14 basin bugs
No precips
Becomes ephemeral
to highway and the
Little Wind River

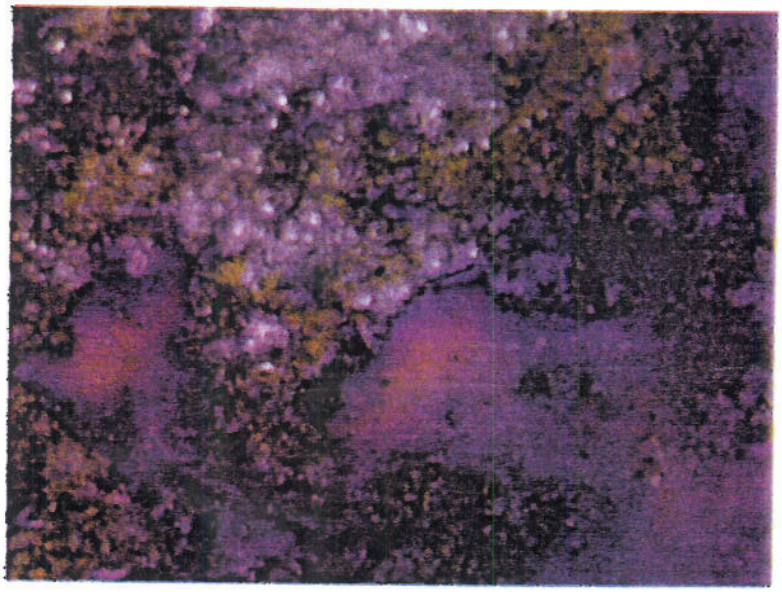

Site=W-1.5
Pond with
dead
ducklings
DO=.93mg/l
Temp=86F
Rich=5 low DO tolerant
Precips heavy
Sp Co
DO=2.
Temp=
Black
in sedi
0.391.34 Miles
1.625.91 Miles
0.632.03 Miles
0.197.65 Miles
0.795.23 Miles
Site= W-1
Sp Cond=2555uS
DO=1.7 mg/l
Temp=100.4F
Richness=0, amacros
Some precips
Site= W-4
Sp Cond= 276
DO= 4.5 mg/l
Temp=68 F
Rich=14 basin
No precips
BIGHORN
WINTERS
DOME
RIDGE
WINKLEMAN DOME
OIL FIELD
Key
= non-supporting,
=partially supporting
=fully supporting, prod water influenced
= fully supporting, normal basin fauna



W1-2:The high water temperatures (100 degrees F) helped to create reducing conditions along the stream edges Sulfur bacteria and Cyanophyta were common. on the sulfur deposits

W1-3:This water was very high in sulfides and the high water temperatures helped keep them in solution. There was low DO because of the sulfides, the high temperatures, and the lack of macrophytes. This stream reach is devoid of macroinvertebrates.

Site W1.5-1: Dead ducklings were found at the edges of this pond on a previous field trip. The pond is dominated by black ooze and reducing conditions.



W1.5-2:Red and red/purple colored growths were observed growing on the sediments at the edges of the pond and are probably thermophilic sulfur bacteria and cyanophytic growths.

Site W-2 and the stream segment from the pond outlet at W-1.5 to the head of the entrenched cattail gully (dark pink)

NPDES sites

Site	Site name	Str or Lk name	II_Geology	VI_Ros I_1	VI_Ros II_1	VI_Ros I_2	VI_Ros II_2	elev	Lat	Long	VIII_Anth_Ps_6	IX_Degree_6	Lim Season_6	X_Status	XI_Mgmt
W-2	Winkleman above cattail gully	Winkleman NPDES creek	Sed	C	precip on 6	C	precip on 4	5708	43° 09' 12.1"N	108° 53' 22.6"W	NPDES_O&G	Dep	AS	PS	Perm

This stream segment is not as entrenched as the segment above or below and the channel is tentatively classified as a Rosgen C. The substrate consists of heavy precipitates either on black ooze or on sand and gravel in the faster sections.

The water in this stream segment is very turbid and cloudy and is dominated by the precipitates As the temperatures start to cool (86 degrees F) the sulfides are changed to sulfates (Compare Fig. 1 and 2) and

many of the minerals are precipitated out. The turbid water and the precipitates exclude any plants and photosynthesis. The DO in this stream section is even lower than the first segment at .93 mg/l.

Five species of macroinvertebrate were found, all very rare and all low DO tolerant (please see attatched bench sheets and macroinvertebrate report). Photo W2-3 shows the rattail maggot with its telescoping respiratory tube that allows it to get its oxygen from the air, rather than from the water. This section of stream is color coded dark pink on the map to indicate it is dominated by low DO tolerant macroinvertebrates.

W2-1: This stream segment is cooler and the high concentration of sulfides and other minerals precipitate out. The zone is partially supporting and has 5 species of low DO tolerant macroinvertebrates.

W2-2:The red arrow indicates the start of the cattail choked entrenched gulley that cleans up the water dramatically in less than ½ mile distance.

Site W-3 and the stream segment through the entrenched cattail gully; site W-2 to site W-4 (green)

NPDES sites																
Site	Site name	Str or Lk name	II_Geology	VI_Ros I_1	VI_Ros II_1	VI_Ros I_2	VI_Ros II_2	elev	Lat	Long	VIII_Anth_Ps_6	IX_Degree_6	Lim Season_6	X_Status	XI_Mgmt
W-3	Winkleman Dome in cattail gully	Winkleman NPDES creek	Sed	G	6c			0			NPDES_O&G	Dep	AS	FS	Perm

This stream segment is classified as a modified Rosgen G-6c and is an entrenched gully that is choked with cattails that slow the velocity of the water and allows most of the sulfides to be deposited as deep black ooze.

We have added the c to the Rosgen 6 class to signify that the sediments are deep, black in color (probably from iron sulfide), and result from anaerobic conditions in the sediments. This is the sapropel of Rutner (1972), and others.

The temperature drops to 69.8 degrees F at this site and the DO climbs to 2.51 mg/l. The thick cattails change the water quality in the short distance of about .4 miles. Fig. 2 shows the deposition of sulfate, 42,000 mg/l, iron, 25,400 mg/l, and sulfide 6,300mg/l in the thick black ooze and sediments surrounding the cattail roots. The much lower values for these parameters in the sediments at W-4 illustrates the dramatic effect this entrenched wetland has on the water quality (sulfate, 1970 mg/l, iron, 17400 mg/l, and sulfide, 1200mg/l).

W3-1: This gulley is about 15 to 20 feet deep and choked with cattails that slow the velocity of the water and allow for precipitates and sediments to settle out.

W3-2: This entrenched cattail gulley is about ½ mile long and improves the water quality dramatically.

Site W-4 and the stream segment from W-4 to the ephemeral reaches above the Ethete Highway and the confluence with the Little Wind River.

NPDES sites															
Site	Site name	Str or Lk name	II_Geology	VI_Ros I_1	VI_Ros II_1	VI_Ros I_2	VI_Ros II_2	elev	Lat	Long	VIII_Anth_Ps_6	IX_Degree_6	Lim Season_6	X_Status	XI_Mgmt
W-4	Winkleman Dome below catail gully	Winkleman NPDES creek	Sed	C	4	C	6c	5618	43° 08' 16.9"N	108° 51' 30.6"W	NPDES_O&G	Inf	AS	FS	Perm

Site W-4 is tentatively classified as a Rosgen C4 with 6c sediments being found along the riparian edges, fully supporting of the beneficial uses for all seasons and produced water influenced. There was a slight rise of both the TDS (1,910 mg/l) and the specific conductivity (2,760 mg/l), probably because of the evaporation and much reduced discharges through this section. There is also a slight rise in aluminum and iron probably for the same reasons or because of new geologies that are influencing this stream segment.

Twelve species of macroinvertebrates were recorded that are typical of basin stream fauna that are still influenced by produced waters.. Fish were not present but this could be due to the no/low water and physical barriers present between these segments and the Little Wind River.

W4-1: The stream and stock ponds from W-4 downstream to the Little Wind River are fully supporting of their beneficial uses.

W5-1: The lower stock ponds hold water year around.